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Estimation of Long-run Relationship between Crude Oil and US' Dollar Value: A Cointegration Analysis

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Abstract

Crude oil price and US dollar value are the two critical economic variables influencing global economy. The purpose of this research is to study the sustained long-run relationship between these two variables. The fact that Crude oil price is determined in dollar and that oil price and dollar exchange rate, since 1970, underwent many changes at international markets raised this question that what is the relationship between these two variables. For this purpose, co-integration and causality tests were used for variables within 1990-2013. Research results show that there is a negative relationship between crude oil price and dollar value such that if the real price of crude oil increases up to 10%, dollar real value decreases to 1.7%. Causality direction is from oil price variable to US dollar price. In addition, estimating short-term error correction relationship for dollar exchange rate long-run equation, it is seen that if dollar real exchange rate deviates from its long-run trend, the gap will be restored at 4.1% rate per period as long as returning to the very long-run path.

Keywords: Crude oil price, US dollar value, Johansen and Juselius Cointegration Method, Vector Error Correction Model (VECM).

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Introduction

To most observers, it is quite evident that increased oil price since 2006 up to mid-2008 and reduced dollar value, are correlated events; and or, there is a casual relationship between these two. As oil is priced in dollar, it appears that once dollar value declines, purchasing power of oil producers also decreases. This issue makes oil producers determined to reduce market supply in order to exert pressure on increased oil price and to restore their purchasing power. This kind of attitude seems somehow reasonable as taking a look at some events, for instance, 1973 and 1979, when oil price rapidly increased in response to measures adopted by Organization of the Petroleum Exporting Countries (OPEC). In fact, according to OPEC expressed objectives relying on implying coordinated oil policies among members to ensure sustained and fair prices for oil producers; further, to assure an efficient, stable and economic oil supply for consumer states; and a fair return on capital for oil industry investors, changes in oil price and supply seems proper. For instance, once oil price per barrel approached to 147$ in the mid-2008, oil price per barrel in the late-2008 reduced to about 100$. Responding to oil price reduction, OPEC announced that it would decrease oil production up to 500’000 barrels per day.

Anyway, data show that oil price increase from 2006 onwards and a fall in oil price recently does not merely result from reduced global oil supply; rather, a series of factors including oil slow production growth and increased demand, particularly in developing countries may be effective. Moreover, the decline in dollar international currency value is likely caused by several factors such as change in capital supply and demand in US economy, the relative rate of return on assets that are sensitive to interest rates, and finally the expectations on US economy performance; however, some market observers give a critical role to oil market speculators respecting to oil price increase.

In most cases, there is no direct and precise relation between oil price and US dollar value; however, there are some channels through which these two variables are indirectly related. Indeed, increase in oil price to offset the decline in purchase power due to dollar depreciation can lead to a series of events that may decelerate oil price ascending and or even override and cause interactive effects on exchange rate. Dollar value and oil price influence other economic factors and considered as a stimulus for world economic development. Any change considerably influences international trade and economic activities in all countries. The important point in the relationship between these two key variables is that whether they change independently or not. What theoretical basics are able to explain effective paths? What are the experimental evidences on statistical relationship?

Theoretical foundations

Theoretical interpretations of the relationship between oil prices and exchange rates are in the two main paths. The first concentrates on oil as the determining factor and key element of terms of trade. In this regard, Amanoand Van Norden (1998) presented a straightforward model including two parts one for tradable and the other for non-tradable goods. Both sectors utilize two tradable (oil) and non-tradable (labor) inputs. The price of tradable product is internationally determined; thus, real exchange rate is determined based on product price in non-tradable sector. Increase in oil price leads to decline in labor price such that maintain competitiveness requirements of tradable sector. If non-tradable sector excessively consumes energy comparing tradable sector, the product price increases in the case of increased oil price; thus, consequently real exchange rate also intensified. If non-tradable sector consumes less energy than tradable sector, the result would be reversed. The problem with this analysis is micro-economy hypothesis. This issue has neglected this fact that tradable prices can be globally increased following oil price shock. Considering this issue and assuming unit prices in tradable sector, it is concluded that changes in real exchange rate following oil price shocks largely depend on energy consumption intensity at both tradable and non-tradable sectors in all understudied countries.

The second class of theoretical discussion, which is presented in more details in the following, concentrates on payment balances and consequently on tradable sector and international portfolio priorities (Krugman, 1983; Golub, 1983). In this statement, increase in oil price is viewed as a mechanism transferring wealth from oil-importing countries to exporting ones. The effect of oil increased price on exchange rate depends on distribution of oil imports among importing countries and on portfolio priorities of oil importing (those with reduced wealth) and exporting (those with increased wealth) countries. Crogman assuming that OPEC uses its accumulated wealth to increasingly import more goods from industrial countries offered some dynamics to the model. Therefore, real exchange rate, in long term, depends on OPEC importing geographical distribution rather than portfolio priorities. Given that oil exporting countries have strong priorities on US dollar assets than goods; thus, emerging of an oil shock leads to dollar enhancement in short-term; while, in long term weakens dollar.

These two theoretic analysis classes were established based on the assumption of three countries (US, Europe, and OPEC) and two monetary units (dollar and Euro). Further, it is also assumed that exchange rate of oil exporting countries has been established in dollar. Gallub further studies revealed similar qualitative results for four countries and three currencies.

The possibility of long-run relationship between oil prices and dollar effective exchange rate indicates the causality between these two variables. Some studies showed a causal path from oil price to dollar (Amano, Van Norden, 1995; and Quere Benassy, 2007). Some other studies imply another causal relationship from dollar to oil. Two types of casual relations are sufficiently examined in term of theory and it is intended to achieve desired results in any case.

The effect of dollar exchange rate on oil demand and supply

Since most oil purchases are paid in dollars and as oil demand depends on local currency price of oil consuming countries; hence, oil demands undergone changes by dollar variations. Therefore, dollar decreased value would reduce oil price in national currency for countries with floating exchange rate like Euro zone and Yen. This effect is neutral to countries such as China that has fixed exchange rate system in dollar. Dollar devaluation makes oil cheaper for countries importing this fossil fuel leading to increased real income and increased oil demand. Therefore, dollar devaluation, at first stage, positively influences oil demand such that it contributes in increasing oil price.

On the other hand, oil companies use national currencies of oil producing companies to pay the costs for labor, tax and other expenditures. These currencies usually rely on dollar as most oil producing countries own fixed exchange rate system. Dollar variations probably influence producers expected price less than demanders expected price.

Drilling activities are also associated with oil price such that when oil price goes up, some difficult and still not so profitable extraction processes may turn into profitable and production capacity increases. Experimental evidences confirm the positive relationship between the two variables in North America, Latin America and Middle East. Anyway, it may not be true for European and African countries. The relationship between oil price and dollar and drilling activities dramatically changed since 1999. However, it is difficult to state that this change originates from oil price decline in 1998 and 1999 or since the beginning of the euro as competitor money in 1999.

Devaluation in dollar also causes inflation and reduces revenues in oil producing countries where exchange rate is correlated with dollar. All countries will similarly not be affected. OPEC, which imports more goods from US, is less influenced comparing countries importing more from Europe and Asia. The increase in inflation and reduced purchase power decrease real disposable income; and hence, revenue available for drilling operations or anything like that. In general, a unit of dollar devaluation may lead to dropped oil supply.

In short term, supply to changes in price shows poor elasticity. Elasticity to increasing price is low due to limited production capacity. Elasticity to price decline is also weak as marginal costs of production are often low or below sales price that makes producers not to limit productions as long as prices are dropping. In short term, demand is also relatively inelastic to price, which may result from lack of substitutes for oil. Totally, supply and demand are inelastic in short term.

The effects of oil prices on supply and demand are clearly seen in long term. Supply is elastic in this time period. Since other energy sources for oil substitution may develop. In general, as Carnot and Hagege also mentioned, if short-term expectations emerged, you may anticipate for anything happen. Expecting price increase forces buyers to purchase that causes increase in black prices. Whereas, if expectations are in long-run; then, anticipating for continued higher prices may bring out a mechanism enabling to reduce long-run price. Therefore, market mechanisms serve as a force that may generally prevent the gaps in equilibrium prices.

Dollar effective devaluation, totally, causes increased oil demand and decreased supply, particularly in long-run when it tends toward oil price enhancement. The first decade of 20th century is a good instance for this mechanism. As indicated by Hagege and Carnot, oil price increase stems from two simultaneous factors: on one side, a great wave of incorrect prediction of oil demand emerged, particularly in America and China; on the other side, decline investment in oil sector led to a depression in production capacities. In such conditions, the role of supply side factors may intensify the risk of deficiency.

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Anyway, though the effects of such changes in exchange rate on oil supply and demand can well describe the events after 2000; it is still unable to explain the results of some experimental studies obtained contradictory (opposite) results; dollar devaluation was associated with decline in oil price rather than any increase.

Oil price effect on dollar effective exchange rate

There exist several reasons believe that oil price could affect exchange rates, in particular USD. Different interpretations express that oil exporting countries are interested in financial investments in dollar (Van Norden and Amano, 1993, 1995). In this framework, increase in oil price augments wealth in producing countries and consequently enhances the demand for dollar assets.

Other interpretations may also be found in summarized exchange rate models like Farugee (1995) model or generally, behavioral equilibrium exchange rate pioneered by McDonald and Clark (1998). In this approach, two independent variables, constantly used for explaining exchange rate are exchange and pure relation of foreign assets. However, oil price particularly affects these two variables through which confirms their effects on exchange rate.

At first glance, it appears that there is a negative relationship between oil price and dollar exchange rate i.e. increased oil price worsens US exchange relation; and then, leads to dollar devaluation. In addition, rising oil prices can have corresponding effects on US current account deficiency, which has been intensified; this also leads to net loss of US foreign assets (even if oil revenues are returned into dollar). At this time, dollar devaluation must occur in order to stabilize US foreign status and competitive power around the world. Anyway, earlier studies were not completed ignoring multilateral nature of exchange rate or treating simply at surface. A more complete argument enables us to explain positive relations is usually stated in literatures comparing relative effects of changes on US to its business partners. In the case that US is a critical oil importer, oil price rising may deteriorate the condition. However, If US imports less oil comparing other main countries like Euro zone nations and or Japan, its relative status may also be improved. Thus, an increase in oil price may lead to increase in dollar value comparing Euro and Yen and finally to dollar effective increased value.

Research experimental background

Coudert et al (2008) studied the relationship between oil price and dollar real exchange rate in long-run. The results showed that the causality is from oil price to dollar exchange rate. According to results, by 10% increase in oil price log, 4.3% dollar real exchange rate is enhanced. Moreover, the study error correction model also reveals that in the case of shock occurrence in dollar exchange rate that causes variable deviation from its long-run trend, it is adjusted to 88% per period; in addition, oil impact in exchange rate is expressed through net position of US foreign assets.

Melhem and Terraza (2007) investigated long-run relationship between oil real prices and dollar exchange rate versus Euro within 2000-2006. Co-integration and causality test results show that one percent dollar devaluation leads to 1.95% increases in oil price in long-run (one percent Euro enhancement corresponds 1.88% increases in oil price in long-run). Causality is also from oil price to dollar and exchange rate adjustment speed to its long-run path per period equals 0.12%.

Ozturk et al (2008) examined the long-term relationship between oil price and exchange rate of a small and free industrial country lacking oil sources like Turkey. Using Johansen co-integration method and causality test and by seasonal data from 1982 to 2006, they found that crude oil real and international price is the reason of changes from dollar real exchange rate to Turkish new Lira.

Benassy-Quere et al (2005) also studied the relationship between oil price and dollar real variables. According to data within 1974-2004, 10% increase causes 4.3% dollar valuation in long-term; further, causality is from oil price to dollar. Convergence speed of exchange rate to its long-term path equals 0.88% per period. And finally, Amano and Norden (1998) figured out that oil price is Granger causality of dollar real exchange rate; otherwise is not true. Further studies demonstrated that oil price is the major source of exchange rate shocks in the next period.

Oil price effect on exchange rate of currencies other than USD is acknowledged by many scholars (Akram; 2004, Chen and Chen, 2007; Habib and Kalamova, 2007; Korhonen and Juurikkala, 2007). Usually, such studies concentrate on oil exporting countries' currencies, as there is a direct relationship between currency of these countries and others', which can be even more direct than USD. The clear difference between causality path of these results and many studies on this case including USD indicates that USD can be an exception due to its contribution in oil official trading as currency. Moreover, general studies on the relationship between product prices and exchange rates obtained significant conclusions. In floating exchange rates, many evidences obtained demonstrating that the product prices are influenced by exchange rates; otherwise, is not true (Chen et al, 2008 and Clements and Fry, 2006).

Table (1) presents some studies conducted on the relationship between oil price and exchange rate. These studies show the results of various estimations, which are different in terms of theoretic notions, data definitions and time periods. The interesting point is that many studies applied real values rather than nominal values. Over time, negative relationship between USD and oil price is supported (Cheng, 2008; Krichene, 2005; Yousefi and Virjanto, 2005). However, a considerable group of economists disagree this negative relationship and believe a positive relationship between these two variables (Amano and van Norden, 1998; Benassy-Quere et al, 2007; Schimmel, 2008).

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Table 1 Studies on the relationship between oil price and exchange rate

Author(s)	Path	Causality	Theory	Model	Period	Exchange Rate Data	Oil Data	Method
Chen (2008)	Short-term and long-term, negative relationship excluding 1980s	From USD to oil price	Maintaining purchase power, local, asset and monetary price channel	Supply and demand structure (Borensztein/Reinhart, 1994)	1980-2007	NEER and REER USD	Crude oil mean spot price	Dynamic ordinary least squares
Benassy-(2007)	Co-integration The relation is negative from 2002 onwards.	From real US currency; causality is inverted since 2002	The effect of China and USD and energy growth on its own	Four model (1980) US, China, OPEC and European Union	1974	REER US	Crude price	Hem
Krichene, (2005)	Co-integration, negative effect both in short- and long-term	From USD to oil price	Maintaining purchase power, local price channel	Simultaneous equations model, structural model, and interest rate and NEER	1970-2004	NEER USD index	IMF crude oil price index	VAR
Yousefi and Wirjanto, (2005)	Negative relation	From real USD to oil price	Purchase power keeping channel of oil incomes	Incomplete FX pass-through, oligopolistic rivalry of OPEC	1989-1999	REER USD	Oil monthly spot price of 4 OPEC member countries	Approximating OLS with standard error correction
Yousefi and Wirjanto, (2004)	Negative correlation	From USD to oil price	Purchase power keeping channel of oil incomes and inadequate exchange rate market	Market share model with Saudi Arabia price leadership	1989-1999	REER USD	Monthly and spot prices of WTI, Brent, OPEC	Hausman GMM model and correlation
Amano and Van Norden, (1998)	Positive co-integration	From oil to dollar exchange rate	Oil real price reflects variations in exchange relation shocks.	Single equation with error correction model	1972-1999	REER USD	WTI oil real price	Dynamic simultaneous equation model

Source: OeNB.
NEER: Nominal Effective Exchange Rate; REER: Real Effective Exchange Rate; WTI: Western Texas oil price Index; VAR: Vector Autonomous Regression; VECM: Vector Error Correction Model

Model estimation and data analysis

The Figure 1 illustrates two macro variables of dollar real effective exchange rate and crude oil mean real price (in log). As seen, understudied period is within early 1990 to late 2013. Variables data extracted from International Monetary Fund (IMF) through IFS software. However, it is worth mentioning that the mean nominal price of crude oil is modified by global consumer price index such that the real price is obtained. LRWOIL, according to following figure, indicates real price logarithm variable of crude oil price, which is computed by IMF. LREER variable also shows USD effective and real exchange rate logarithm that is calculated against the country's major commercial partners.

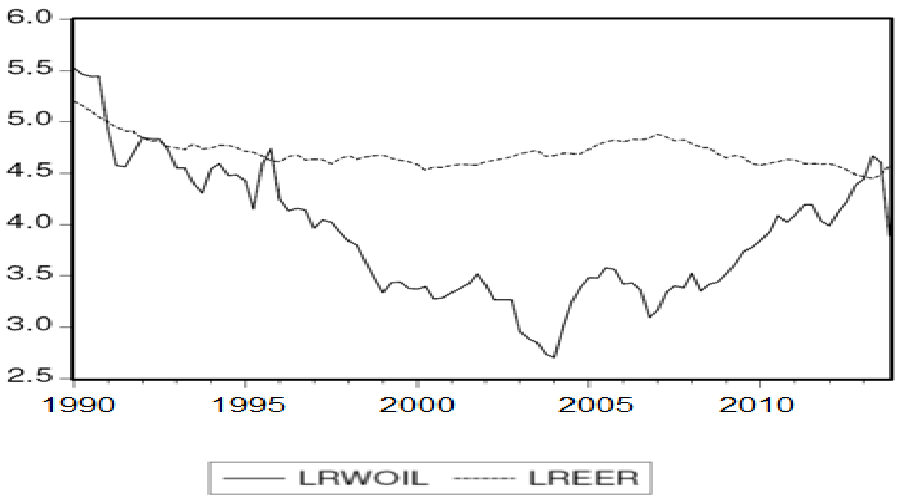

Figure 1. Dollar real effective exchange rate and crude oil mean real price

According to the above figure, the following intuitions are deducted. First, it is evident that effective exchange rate variations indicating competition power of each country (that is US in the present research) is very low. The variable standard deviation is 0.12. This means that US economy competitiveness in the period of interest at international arena undergone little changes; however, negligible decline in dollar effective exchange rate during understudied period showed a small increase in American goods' competitive power versus other nations around the world. Secondly, contrary to the exchange rate, crude oil price, even at real values, highly varies with standard deviation 0.62. As known, oil price influenced by various factors including economic, political and geographical variables; thus, such variations are not surprising. Moreover, considering the two variables' time series graph, it is impossible to certainly discuss about the relation between the two variables; thus, it tries to explain the relationship through econometric and long-run estimation models. In this regard, for more preciseness, seasonal (quarterly) data are used.

Many several methods are provided for determining and explaining the long-term relationship between multiple variables. Engle- Granger method, Auto Regressive Distributed Lag and or well-known Johansen and Juselius method are some instances. The order is chronologically expressed meaning that initially Engle- Granger method was introduced; though, it lacked creditability due to disregarding short-term dynamic reactions between variables since the obtained estimations were biased; as a result, hypothesis testing using regular test statistics will be invalid (Noferesti, 1999). Therefore, using models embracing short-term dynamics and leading to more precise estimation of models are being interested. Auto Regressive Distributed Lag (ARDL) model was introduced and frequently applied in academic papers by calculating long-term relations and short-term reactions. Since this model uses distributed lags for model estimation; thus, this method utilizes many data in order to prevent difficulties of low degree of freedom. On the other hand, there is more than one long-run co-integration vector within several time series variables. In this case, methods such as Engle-Granger and ARDL may not determine these vectors without any default on the behalf of analyst. Johansen and Juselius solved the deficiencies of aforementioned methods by formulating vector co-integration method and introduced a test to determine number of long-run vectors and short-term responses. The third method, in this study, is used to determine the long-run relationship between these two critical variables influencing international economy. If long-run relationship is maintained, the vector error correction equation obtained from this long-run relation is extracted in addition to explaining the relation.

Statistical testing of model variables' time series

Since most macro-economic variables are unstable, and regarding that this model is applied providing that all model variables in Johansen and Juselius co-integration model be of first order, it is demonstrated that the two dollar effective exchange rate and oil real price variables carry this feature; as a result, the present research is permitted to use the above method.

In general, a time series variable is stable when its mean variance is fixed over time and autocorrelation coefficients of several periods of variable of interest is only a function of lags' distance (length).

Table 2 represents test results for these two variables. It is clear that both variables are at unsteady level; though, turns into steady state by differentiating. Accumulation of first order variables makes using Johansen method possible for estimating the long-run relationship between these two variables. Furthermore, the coefficient is the component of a significant intercept; whereas, time series variable coefficient is not significant; thus, only intercept is considered in variables static test.

Table 2 Test results of co-integration order (Dollar real effective exchange rate and crude oil real price)

Variable	ADF test statistics at variable level	ADF statistics test at variables first order difference	Critical value		Test result
			α=99%	α=95%	
Crude oil real price	-2.38	-4.58	- 3.50	- 2.89	Supported (oil real price is stable by one time difference)
USD real and effective exchange rate	-3.14	-6.68	-3.50	-2.89	Supported at α=99% and rejected at α=95% (real and effective exchange rate od dollar is stable by one time difference).

Determining model optimum lag length

Johansen and Juselius co-integration model requires estimating VAR equations system in which determining optimum lag length is of model estimation preliminaries. As determining lags proper number on the model ensures that error expressions related to Wight noise equations; and thus, are static or I (0). It is customary that similar lag lengths are used in system equations in order to maintain symmetry. Since linear correlation between variables at equations' right side leading to serious co-linearity; therefore, t-statistics criterion is not used to determine variables' lag coefficients' significance or insignificance. Hence, of different criteria used for determining optimum lag, Akaike*information criterion* (AIC), Schawrtz-Bayesian criterion (SC), Hanan-Queen (HQ) or likelihood ratio (LR) are used. According to software output results, it is seen that optimum lag length equals one regarding Schawrtz-Bayesian criterion (SC) and Hanan-Queen (HQ). As a result, initially a VAR equations system is estimated with optimum lag length one; then, the number of convergence (co-integration) vectors are determined.

Determining the number of convergence (co-integration) vectors (r)

Long-run relationship is estimated through using Johansen and Juselius method and by the aid of seasonal data within 1990-2013 in five different states from the most unrestricted to the most restricted state. The states are mainly distinguished in term of intercept or trend in VAR model and long-run relationship. Anyway, considering obtained results, the most significant state, which is both statistically and experimentally confirmed is the state in which a long-run relationship with an intercept is assumed lacking trend. It was an expected result as according to model variables' trend in Figure 1, it is impossible to identify a determinate trend for these two time series; further, apparently, the changes are not a function of time. In order to test matrix order and to determine the number of convergence vectors, impact and maximum eigenvalue tests are used in Johansen and Juselius method. Decision making process is as follows: non-existence of any co-integration vector hypothesis is initially tested; if, according to critical quantities, trace statics statistics and or maximum eigenvalue statistics test of this hypothesis are rejected; then, at second step, null hypothesis stating existence of only one co-integration vector is again tested in the previous order; it stops as long as null hypothesis is maintained. Then, number of co-integration vectors is determined along with an estimation model of the number of co-integration vectors. The following table shows the results of testing the number of co-integration vectors.

Table 3 Test of determining the number of co-integration vectors

Hypothesis	Trace statics			Maximum Eigen-value test			Test result
	Test statistics	Critical value		Test statistics	Critical value		
		α=95%	α=99%		α=95%	α=99%	
There is no long-run relationship; (r=0)	22.92	19.96	24.60	17.92	15.67	20.20	Rejected
There is only one long-run relationship (r=1)	5.07	9.24	12.97	5.07	9.24	12.97	Supported

According table 3, null hypothesis stating that there is no long-run relationship is rejected at 95%; therefore, only at least one long-run relationship exists between model two real variables. While, null hypothesis of only one co-integration vector among variables show that null hypothesis is maintained at 95 and 99%. Now, long-run co-integration vector between two variables of oil real price and dollar real exchange rate is obtained as follows:

Table 4 Estimation of Co-integration vectors coefficients

Variable	LRWOIL	LREER	C
Unrestricted	-6.64	-4.15	21.79
Restricted (normalized)	0.17	1	-5.28

As seen in table 4, the normalized vector (+1 and + 0.18) coefficients of long-run relationship between dollar exchange rate and oil price reveals that it is normalized respecting to dollar exchange rate. In the following it is seen that exchange rate in long-run and oil price are endogenous and exogenous and explanatory variables, respectively. Now, long-run relationship is rewritten as follows:

$$LREER = 5.28 - 0.17\ LRWOIL \quad (1)$$
(2.02)

As seen in formula (1), obtained long-run relationship has negative coefficient 0.17, which is statistically significant (the number in parenthesis indicates t-student statistics, which is approximately larger than 2; thus, the null hypothesis of equation zero slope at 95% is rejected and -0.17 is significant). This coefficient is interpreted such that 10% increase in oil real price log leads to 1.7% depreciation of USD real and effective rate logs. It is worth mentioning that the existence of a negative relationship between these two variables is theoretically strong referring to studies like Grackman. The obtained result confirms such hypotheses.

Estimating vector error correction model

Co-integration in a set of economic variables provides a statistical basic to using error correction model. Error correction model links short-term variations in variables to long-run variations. In this section, the estimated vector error correction model for long-run equation is studied. Formula (2) shows error allocation model for dollar real exchange rate equation, which is a one-lag value function of real exchange rate, oil real price variables and error correction term.

$$D(LREER) = -0.004 + 0.2\,D\big(LREER(-1)\big) - 0.03\,D\big(LRWOIL(-1)\big) - 0.041\,ecm(-1) \quad (2)$$

The above relation shows vector error correction relation associated to obtained long-run relationship. As seen, exchange rate equation includes negative and significant error correction term. As mentioned earlier, negative error correction term tends to long-run value in the case of dependent variable deviation. This small value coefficient indicates slow adjustment speed toward long-run balance. In the model of interest, dollar effective and real exchange rate is offset 4.1% if it is deviated from long-run trend per period demonstrating relative slow adjustment speed toward long-run. The results of this study are almost consistent with earlier studies.

Knowing dollar exchange rate short-term adjustment speed toward long-run adjustment speed, it is possible to approximately measure the spent time. If long-run trend diversion at 4.1% growth rate is adjusted per period, it took about 16 periods (4 years) dollar real exchange rate returns to its long-run trend. It is observed that though dollar exchange rate variations are low, if deviated from long-run balance, returning to balance would require a relatively long time.

In the model of interest, exchange rate variable is regarded as model endogenous variable; in precise word, comparing exchange rate variable and oil price, oil price variable is more exogenous than dollar exchange rate; thus, it is irrelevant to examine error correction relation for oil real price equation.

Studying casual relation between variables

Testing casual relation between model variables econometrically validates coefficients of long-run relationship and influence direction, as if the casual relation is from oil price to dollar exchange rate, prior section estimation is totally satisfied and the analyses are reasonable.

Granger Causality Test is the most common method testing casual relation between variables. However, in the case that the two variables are non-static and co-integrated, this test is no more validated (Enders, 2004). In such case, Granger-Sims Causality Test is used, which is based on error correction model (Enders, 2004; Haffman and Crowder, 1996).

According to obtained results of vector error correction model research, it is seen that error correction coefficient test statistics in error correction model equation related to LREER equation is – 3.08; thus, the null hypothesis of causality from oil price to dollar at 95% is maintained.

Due to insignificant error correction coefficient in oil price error correction model, the null hypothesis of lack of causality from exchange rate to oil price is maintained. Therefore, the estimated long-run relationship and obtained coefficients in prior sections are maintained and the interpretations are significant at 95%.

Conclusion and recommendations

The present research results show that there is a sustained, long-run and significant relationship between crude oil real price and dollar real value. In addition, estimation results demonstrate that the relation between two variables is not one-to-one such that 10% changes in oil price leads to inverse change off 1.7% of dollar real value. Causality in long-run is from oil real price to dollar real price; or in other word, oil price is more exogenous than dollar price. In addition, error correction relation showed that dollar exchange rate value as model dependent variable is slowly adjusted if any long-run shock and diversion occurred; and it takes 4 years to recover half of the created diversion.

According to research findings, the following policy recommendations are suggested:

I. Iran economy is an oil-dependent mono-product economy such that over eighty percent of national annual budget rely upon revenues and exchanges of selling crude oil mostly in dollar. On the other hand, conversion of currency income to Rials causes many problems including Dutch disease. Hence, understanding variations in dollar, oil price and the relation between these two is of prerequisites of an efficient budgeting and optimum long-run planning. Research results reveal that oil price in long-run is more exogenous than dollar price in real values. And since oil pricing is done through supply and demand continuum, and further, oil supply is almost authorized by oil-producing and developing countries such as Iran, it is possible to achieve long-run growth and development objectives through adopting the policies leading to more convergence in such countries.

II. USD as a global valid currency is ruling global economy for more than half a century; however, recently, Euro (Europe currency) is announced as a serious competitor for dollar. Of these sever completion among global strong currencies, oil as a strategic substance requires to be considered in international issues, which highlights the role of oil producing countries in global economy. The long-run relationship between oil price and such powerful currencies is investigated for more effective and academic attendance in international competition; however, the present research is only the very first steps. According to results, firstly, the long-run relation is negative and from oil price to dollar i.e. if oil-producing countries' policy makers follow the policies leading to increased crude oil supply; then, in long-run, oil price would decrease and dollar real value increase comparing other currencies; otherwise is true.

References

Akram, Q. Farooq (2004), Oil prices and exchange rates: Norwegian evidence. Econometrics journal 7(2), pp. 476-504.

Amano, R. and Van Norden, S. (1998), Oil prices and the rise and fall of the US real exchange rate, Journal of international money and finance 17. 299–316.

Amano, R. and Van Norden, S. (1993), A forecasting equation for the Canad-U.S. dollar exchange rate, Proceeding of the conference held at the Bank of Canada, June 22-23, 1992.

Crespo Cuaresman, Jesus, and Andreas Breitenfellner (2008). Crude oil prices and the Euro-Dollar exchange rate: A forecasting exercise, University of innsbruck, working Papers in economics and statistics2008-8.

Beckmann, Rainer, Born, J¨urgen and K¨osters, Wim, (2001), The US dollar, the euro, and the yen: An evaluation of their present and future status as international currencies, Ruhr-Universität Bochum. Munich Personal RePEc Archive.

Bénassy-Quéré, A., Mignon, V. and Penot, A. (2007), China and the relationship between the oil price and the dollar, *Energy Policy* 35, 5795-5805.

Carnot, N. and Hagege, C. (2004), Le marché pétrolier, *DP Analyses Economiques* 53.

Chen, S.-S. and H.-C. Chen (2007), Oil Prices and Real Exchange Rates, Energy Economics 29. Pp.390–404.

Chen, Y.-C., K. Rogoff and B. Rossi (2008), Can Exchange Rates Forecast Commodity Prices?, Working Paper. Harvard University, Journal 7.pp. 476–504.

Cheng, K. C. (2008), Dollar Depreciation and Commodity Prices IMF (ed.). 2008. World Economic Outlook. International Monetary Fund. Washington D.C. pp.72–75.

Clark, P. and McDonald, R. (1998), Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs, *IMF Working Paper* 98/00.

Clements, K. W. and R. Fry (2006), Commodity currencies and currency commodities, CAMA working paper.

Enders, Walter (2004). Applied econometrics time series. John Wiley & Sons.

Exchange Rate, Monetary policy & the economy, central bank of the Republic of Austria. CAMA Working Paper.

Faruqee, H. (1995), Long-run determinants of the real exchange rate - A stock-flow perspective, *IMF Staff papers*, Vol. 42, pp.855-881.

Frankel, J. (2003), A proposed monetary regime for small commodity-exporters: Peg the export price, *John F. Kennedy School of Harvard University Faculty Research Papers Series*.

Golub, S. (1983), Oil prices and exchange rates, *The Economic Journal* 93 (371), pp. 576-593.

Habib, M. M. and Kalamova, M. M. (2007). Are there oil currencies? The real exchange rate of oil exporting countries, working paper. European central bank.

Haffman, D. and Crowder, W. (1996). The long-run relationship between nominal interest rates and inflation: the fisher equation revised. Journal of money, credit and banking, 28, pp.102-118.

James K. Jackson (2008), The U. S. Trade deficit, the dollar, and the price of oil, International trade and finance foreign affairs, defense, and trade division, Congressional research service (USA).

Korhonen, I. and T. Juurikkala. (2007). Equilibrium exchange rates in oil-dependent countries. BOFIT Discussion Papers.

Krichene, N. (2006). World crude oil markets: Monetary policy and the recent oil shock. IMF Working Paper.

Krugman, P.R. (1983), Oil and the dollar in: J.S. Bhandari, and B.H. Putnam, eds., Economic independence and flexible exchange rates, MIT Press.

Li Wenhao(2004), Currency competition between euro and Us dollar, Paper No. 18, Working papers of the business institute Berlin at the Berlin school of economics (FHW-Berlin)Badensche Str. 50-51, D-10825, June.

Marglin, S.-A. and J.-B. Schor (eds.). (1990). The golden age of capitalism: reinterpreting the postwar experience. Clarendon press. Oxford.

McKinnon, R. I. (2005). The world dollar standard and globalization – New rules for the game? Working paper. Stanford University.

Mehrara,M. (2006), The relationship between energy consumption and economic growth in Iran, Iranian Economic Review, 10, pp.137-148.

Mothana Saleh, (2006), Do oil prices depend on the value of US dollar?, Journal of Economic Casopis, No. 54, pp.253-265

Schimmel, W. (2008). Is the oil price being driven by a weak dollar? Vienna: Futures FTC Capital.

Sims, C., A. (1972). Money,Income and Causality, American Economic Review, 62, pp.540-552.

Wirl, F. (2008), Why do oil prices jump (or fall)? Journal of policy 36, pp.1029-1043.

Zhang, Y.J., Fan, Y., Tsai, H.T., Wei, Y.M. (2008), Spillover effect of US dollar exchange rate on oil prices, Journal of policy modeling, pp. 973-991.